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Notes on the systematic position of some North American LEPIDOPTERA.

BY JOHN B. SMITH.

Very regularly when specimens of *Eudryas* are sent to European collectors, word arrives that surely these insects are not *Zygaenids*. Moeschler and Snellen positively refer them to the *Noctuidae* and others are not less certain that their position among the *Zygaenidae* is erroneous, though less decided as to their proper systematic position. In 1854–1858 Dr. Herrich-Schaeffer in his magnificent work, the "Sammlung ausser-europaeischer Schmetterlinge," limits certain families of Lepidoptera, carefully defining their characters, and among others the *Zygaenids* are discussed. In 1862 Clemens, speaking of the same family says: "I am convinced that the limit of the family under consideration is much more restricted than is usually represented. It is made to include a variety of incongruent forms, which it is extremely difficult to unite under a common and satisfactory definition"

Had Dr. Clemens been acquainted with the insects at present classed as *Zygaenidae* in our catalogues and lists, he would have written "impossible," for "extremely difficult."

In 1864 Dr. A. S. Packard, Jr., in the Proceedings of the Essex Institute vol. iv, published his "Notes on the family *Zygaenidae*" in which he carefully compares the structural peculiarities of European and American genera. All the preceeding works on the group are noted, and among them Herrich-Schaeffer's "Sammlung." Dr. Packard regards this work with little favor, and evidently did not read the notes appended to the synopsis of families, else he would hardly have criticised the supposed arrangement of families, which Herrich-Schaeffer especially says is proposed merely for convenience of determination. The Herrich-Schaeffer system is largely based upon venation and his work is still followed by the German lepidopterists, and forms the basis of the arrangement in Staudinger's Catalogue of European Lepidoptera.

Dr. Packard gives very little weight to peculiarities of venation, and his idea of the family *Zygaenidae* embraces the greatest possible diversities in this respect to be found among the *heterocera*. His arrangement has, however, been acquiesced in by subsequent workers, and Mr. Grote's discussions of the family have added nothing to our knowledge of the group, save several new genera and species.

Mr. Stretch, too, has followed Dr. Packard implicitly. My own idea had long been, that the family was too heterogeneous; but as my studies had been more especially in the noctuidae I had contented myself with simply making occasional notes of observed peculiarities. The question of adopting *Eudryas* as a noctuid, forced upon me by the opinion of so good a Lepidopterist as Moeschler led me into an examination of some of the genera, and the result of this examination and of the accumulated notes is here given.

The European genus *Zygaena* which is admittedly the type of the family has 13 veins to primaries and 9 to the secondaries. *Ino* has 10 veins to the secondaries, three of them being "free" or internal veins. The primaries have two distinct free or internal veins, no accessory cell, and a somewhat constricted discal cell. The secondaries have an oblique branch connecting the costal and subcostal. Figure 23 of Plate III illustrates the venation of *Zygaena*. As stated, Dr. Packard seems to place little reliance upon venation, but gives great weight to the form of the head. This in *Zygaena* is broad, the front full, subquadrate; the eyes hemispherical. The antennae are situated midway between the eyes and the middle of the head and are therefore rather approximate. Immediately behind is a deep transverse fovea, at the extremes of which the minute ocelli are situated. Behind this is a broad divided ridge overshadowing the base of antennae. Figures 1, 5 and 9 of Plate III illustrate the structure. All the examined species of *Zygaena* agree in this head structure. *Ino* differs in having a normally smooth vertex and epicranium and very large, prominent ocelli. The situation of the antennae is as in *Zygaena*.

No American form referred to the *Zygaenidae* agrees with *Zygaena* in head structure, though *Cossus Robinae* makes some approach to it; and no North American genus examined agrees with either *Zygaena* or *Ino* in venation. The body structure of *Zygaena* and *Ino* practically agree and it is peculiar by the strong development of the prothorax. The pronotum is small, but distinctly visible, and the episterna are divided (see pl. III f. 13), a character not paralleled in any N. A. genus. It may be added here that the secondaries are frenate; in the ♂ a single stout bristle as usual, in the ♀ a bunch of 5 or more stiff hairs.

The genital armature of the ♂ is very simple, and very unlike that of the lower moths. The ordinarily strongly marked supra-anal plate with a well marked corneous hook is entirely wanting and only the broad spoon-shaped side pieces are developed (See pl. III f. 16 and 18).

The antennal structure in *Zygaena* is peculiar; the member is stout, dilated toward and obtusely terminated at tip.

Ino differs in having the antennae pectinated in the ♂. So strongly marked are the differences between *Zygaena* and *Ino* that it seems to me that distinct sub-families are indicated.

Pyromorpha H-Sch. most nearly agrees with the true *Zygaenidae* in venation of primaries—(compare figs. 23 and 24 pl. III) but differs very essentially in venation of secondaries, in which the costal vein is entirely wanting. The head structure is not unlike that of *Ino*, and the ocelli are large and prominent. The family *Pyromorphinae* H-Sch. as based on this genus is well founded, and should be recognized.

Harrisina Pack. is a much narrower winged insect and yet agrees in essential characters with *Pyromorpha*. It should be associated with it. *Acoloithus* Clem. very probably should be referred to the same family, but I have not been able to examine the species carefully. The antennae are not thickened but are lengthily pectinate in the ♂.

Several others of our genera lack the costal vein of secondaries, but differ very decidedly in other respects.

The *Syntomoidae* are defined by Herrich-Schaeffer as small butterflies with filiform antennae, long abdomen and short secondaries; ocelli wanting, tongue corneous. Primaries with one internal vein, 7–10 from the same stalk, a long distance between 5 and 6. Secondaries with five or six veins.

To this family, which differs so decidedly in venation from *Zygaena*, I would refer *Lycomorpha*, *Anatolmis*, *Cosmosoma* and probably *Syntomeida*.

Lycomorpha is unlike *Syntomis* in superficial appearance, but agrees in essential structural details. The secondaries lack the costal vein and have only one internal vein. The subcostal is furcate at the end of the cell, and the submedian is three branched. There are therefor but six veins. Dr, Packard figures the head structure, which is essentially like *Pyromorpha*, save that the ocelli are wanting. The genus is a peculiar one, with strong affinities to the *Lithosiids*.

Anatolmis is like *Naclia*, save that the ocelli are present. The secondaries are six veined, and in the primaries 6–9 are from one stalk. The genus is intermediate in structure between *Lycomorpha* and *Cosmosoma*.

Cosmosoma resembles *Syntomis* in having partially pellucid wings but differs by having the ocelli evident. I have been unable carefully to examine species of *Syntomis*, and am not in a position to make comparisons. The affinity of these forms with pellucid wings to the *Sesiidae* is marked by the internal vein of the primaries being very close to the margin (in *Sesia* it is absent) and by the absence of the costal vein of secondaries. In this genus the "independent" vein is feebly indicated in the secondaries, and they are thus 7 veined.

The family should follow the *Sesiidae*, forming through the genera *Lycomorpha* and *Anatolmis* the connection with the *Pyromorphidae* on the one hand, and the *Ctenuchidae* on the other.

The antennal structure in these genera agrees essentially with that of the *Pyromorphidae*, and they are very similarly placed.

Ctenucha and *Scepsis* agree essentially in structure. The secondaries lack the costal vein, but have two free, or internal veins, thus differing at once from the *Syntomoidae.* The venation of primaries takes a decided *Bombycid* or even *Noctuid* character, and the affinities to the *Arctiidae* are strongly marked. The larva sustains this view, and forms a strong argument against a union of *Ctenucha* with the *Zygaenidae.* A reference to the figures of Plate III will enable the student to make his own comparisons.

While I do not think the head structure entitled to nearly as much weight as Dr. Packard gives it, yet in all the genera hereinbefore discussed there is one element of head structure entitled to great weight, and that is the position of the antennæ. In the *Noctuidae* they are inserted close to the compound eyes and as far apart as the width of the head will allow. In the *Zygaenidae* and the above mentioned families they are situated midway between the compound eye and the centre of the head, and the basal joints are therefore contiguous. The ocelli, too, are situated at a distance from the compound eye, and from the base of antennæ, and are often unusually large and prominent. In the *Noctuidae* they are close to the compound eye and close to the base of antennæ so that in most cases they are easy discernible with a lens without denuding any portion of the head. No *Bombycid* genera have been compared, for that would have exceeded the purposes of this paper.

The families above discussed can be separated in tabular form so as to give a convenient comparative survey, as follows:

Primaries with two internal veins.
  Secondaries with costal vein connected with subcostal by an oblique branch; with two or three internal or free veins.............. ....**Zygaenidae.**
  Secondaries without costal vein ....**Pyromorphidae.**
Primaries with a single internal vein; secondaries without costal vein.
  Secondaries with a single internal vein, and not more than a total of 7 veins. **Syntomoidae.**
  Secondaries with two internal veins; always with 8 veins.....**Ctenuchidae.**

Up to the present point there is no especial disagreement between the results of my study and those reached by Dr. Packard. I simply give a higher value to characters of venation, and believe, that judged according to the amount of variability shown in other groups that these families are well founded. It is further an advantage to have compact groups easily separable on defined characters, rather than a mass of genera and species absolutely incapable of definition.

As to the position of *Eudryas* and *Alypia* I am decidedly of opinion that their place is not with the *Zygaenidae* for there is hardly a structural feature common to *Alypia* and *Zygaena;* nor is their place with the *Castniares.* Further *Alypia* and *Eudryas* have so little in common, that I would refer them to distinct families. Plate III figures 3, 7, 10 and 27 illustrate *Alypia,* while 2, 6 and 11 illustrate *Eudryas.*

Dr. Packard's figures on Pl. 2, and accompanying his paper are somewhat misleading, and not entirely in accordance with the specimens examined by me. In the figure the front seems narrowing inferiorly, while on the contrary in those specimens examined by me the front narrows superiorly. In my plate the eyes are somewhat too large in fig. 3, but otherwise I believe the figures accurate. Dr. Packard's figure of the head of *Eudryas* makes the front too narrow, and in no specimen examined by me is there the central depression of the epicranium. *Alypia* is peculiar in head structure, especially by the form of the eyes. These consist of slightly convex disc so placed that from the front they have the normal appearance, but from the side or top (figs. 7 and 10) the essential difference between them and those of *Eudryas* and *Stiria* (figs. 6–8, 11 and 12) are quickly perceived. Between the facetted disc of the true eye, and the back of the head, is situated a broad velvety black piece which is not facetted. In no other form known to me is this structure found, the eyes usually occupying the entire side of the head. The clypeal structure affords nothing not paralleled in the *Noctuidae.* The antennæ are rather close together at base but this is rather the result of the narrowness of the head than of any peculiarity of position. Yet they show a *Zygaenid* tendency in not being entirely close to the compound eyes. The antennæ are rather elongate slightly thickened toward the middle, but rather acutely terminated. The thoracic structure differs from *Zygaena* in the poorly developed prothorax; the pronotum is not visible at all, from above, and the episterna are single. A comparison of figures 13 and 14 on Plate III will illustrate the differences. Except the structure of the prothorax there is nothing in the difference of thoracic structure not parallel in the *Noctuidae.* In *Eudryas* the body structure is essentially as in *Alypia.* The neuration of *Eudryas* and *Alypia* agrees essentially, and except in one point is like the typical *Noctuid*, and as far as it is possible to be from that of the typical *Zygaenid.* If any value at all is to be accorded to venation in classification it is utterly impossible that *Zygaena* and *Alypia* can remain in the same family. A comparison of figures 23 and 27 will explain better than any lengthy description. The presence of an accessory cell, the distribution of veins therefrom and the number and arrangement of veins of secondaries; all are distinctively noctuiform. The only difference is that the internal vein of primaries is not furcate at base. This character keeps *Alypia* and *Eudryas* out of the *Noctuidae.* The difference is illustrated in figures 21 (*Eudryas*) and 22 (*Noctua*). The structure of the frenae of the ♀ *Zygaena* has been noted. *Alypia* and *Eudryas* have in the ♀ two or three well defined spines, very different from the bunch of stiff hair found in *Zygaena.* To this character I am inclined to attribute considerable importance, because it is one which varies little or not at all in any group in which it is present. Mr. Hulst informs me that some *Notodontids* and *Geometridae* are like *Zygaena* in this respect.

The structure of the ♂ genitalia is very different from that of *Zygaena* and the difference is not one of degree but of kind. The supra anal plate is present, is corneous, triangular, and produced into a cylindric curved hook (Pl. 3, f. 20). This is a character distinctly marked in all the *Noctuidae* and such of the *Bombycidae* as I have examined, and is distinct in the *Sphingidae.* The *Hesperids* are not unlike *Zygaena* in this respect. The side pieces are semi-chitinous, thickened and somewhat curved. (Pl. III, f. 17). This structure is certainly entitled to great weight in classification and should authorize the exclusion of *Alypia* from the family in which *Zygaena* is placed. The only *Zygaenoid* feature in the genus is the antennal structure, and even this is very unlike the genus *Zygaena.* These members have been already described, and their only departure from the normal *Noctuid* type is the slight thickening toward the middle. This is not equally prominent in all species, and in itself is not a controlling character, since in *Zygaena* even as restricted some of the species have more or less filiform antennæ.

Alypia is much more nearly allied to *Noctua* than to *Zygaena* but is entitled to family rank, its position being intermediate between the *Arctiids*, and *Noctuids*, with affinities toward the *Zygaenidae.* The distinguishing features of the family are the thickened antennæ and the lenticular eyes, which do not occupy the entire side of the head.

Eudryas is still less *Zygaenoid* in structure than is *Alypia*. Under the term *Eudryas* I include as well *Ciris* and *Copidryas*, not because I consider them synonyms, but because they seem to agree in essential family structure. The head structure is essentially *noctuiform*, and less like *Zygaena* than *Alypia*. The antennæ are more *noctuidous*, those of *Ciris* being bipectinate in true *Bombycid* fashion. The body structure differs in nothing from the *Bombycidae* or *Noctuidae*, and does differ from that of *Zygaena*. In the character of the ♂ genital pieces the genus is still more decidedly *noctuidous* than *Alypia*. The supra anal plate is present, much as in *Alypia*, but the hook-like projection is not cylindrical but flattened and somewhat spatulate (Plate III, fig. 19). The side pieces are membranous, arcuate, and somewhat incurved toward tip. Near the base of the side piece arises the corneous or chitinous clasper, which is longitudinally grooved, furnished with a trigonate inferior projection near middle, and furcate toward tip. Figure 15 of the plate gives a better idea of the structure than any description can do. This structure thoroughly agrees with that of the *Noctuidae*, or of the noctuiform *Bombycids*, and is very different from both *Alypia* and *Zygaena*. Altogether this insect is structurally as widely separated from *Zygaena*, as the *Bombycidae* are from the *Noctuidae*—nay further, because these families agree more nearly in body structure and in venation, than do those genera placed into the *Zygaenidae*.

The true position of *Eudryas* is, it seems to me, very close to where Harris put it—*i. e.* allied to *Datana* and the *Notodontids*. The wing form, the body vestiture, the elongate abdomen, the metallic scales, tufted legs; all are *Bombycid* characters which cannot possibly be disregarded in any reasonable classification. Though the larva are so nearly alike that they are scarcely to be distinguished except by careful comparison, yet I do not believe that *Alypia* and *Eudryas* are closely allied, and favor their separation, giving them place in distinct families.

In Mr. Meyer's grand collection of South American insects the *Castniares* are largely represented; and, though I made only the most casual comparisons, yet I am firmly of opinion that neither *Eudryas* nor *Alypia* can remain associated with them.

Of the other genera found under the general head *Zygaenidae* in Mr. Grote's catalogue, *Gnophaela* belongs to that "debatable ground" between the *Lithosiidae* and the *Arctiidae*. The venation is *Lithosiid*. *Cydosia* I have not examined. *Penthetria* is a composite genus, apparently containing heterogeneous forms. *Triprocris* has not been under examination, nor have *Horama* and *Laemocharis*. *Pseudalypia* I have not seen in nature, and *Edwardsia* has been only superficially viewed. *Psychomorpha* I have had no specimens of that I could denude, but it seems close to *Alypia*.

No exotic material has been compared except as above stated, because it was not intended to do more than separate into compact, easily definable groups that composite mass termed in our lists *Zygaenidae*.

To resume, my arrangement of the genera here discussed would be provisionally as follows:

Zygaenidae not represented.

Syntomoidae *Didasys* Grt., *Cosmosoma* Hb., *Syntomeida* Harr., *Anatolmis* Pack., *Lycomorpha* Harr., *Horama* Hb. (?), *Laemocharis* H. S. (?)

Pyromorphidae *Pyromorpha* H. S., *Harrisina* Pack., *Triprocris* Grt.

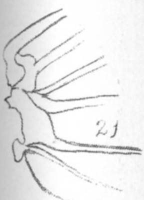
Ctenuchidae *Ctenucha* Kirby, *Scepsis* Walk.

Alypiidae *Alypia* Hb., *Pseudalypia* Hy. Edw. (?), *Edwardsia* Neum. (?), *Psychomorpha* Harr.

Eudryas and allies find a place in the *Bombycidae*.

EXPLANATION OF PLATE III.

1.—Front view; head of *Zygaena*.
2.—Front view; head of *Eudryas*.
3.—Front view; head of *Alypia*.
4.—Front view; head of *Stiria*.
5.—View from above; head of *Zygaena*.
6.—View from above; head of *Eudryas*.
7.—View from above; head of *Alypia*.
8.—View from above; head of *Stiria*.
9.—Side view; head of *Zygaena*.
10.—Side view; head of *Alypia*.
11.—Side view; head of *Eudryas*.
12.—Side view; head of *Stiria*.
13.—Thoracic structure of *Zygaena*.
14.—Thoracic structure of *Alypia*.
15.—Side piece and clasper of *Eudryas*.
16.—Side piece of *Zygaena*.
17.—Side piece of *Alypia*.
18.—Genitalia of *Zygaena* from below.
19.—Supra anal hook of *Eudryas*.
20.—Supra anal hook of *Alypia*.
21.—Distribution of veins reaching base in *Eudryas*.
22.—Distribution of veins reaching base in *Noctuidae*.
23.—Venation of *Zygaena*.
24.—Venation of *Pyromorpha*.
25.—Venation of *Cosmosoma*.
26.—Venation of *Ctenucha*.
27.—Venation of *Alypia*.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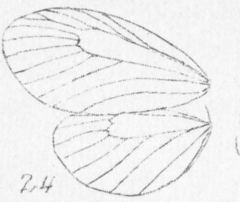
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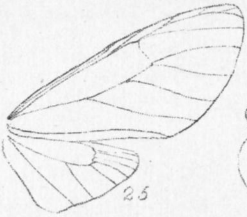
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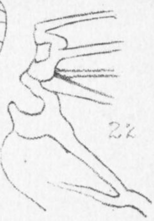
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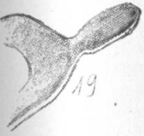
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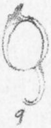
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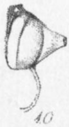
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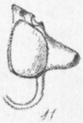
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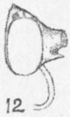
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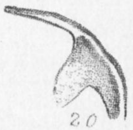
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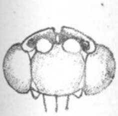
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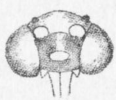
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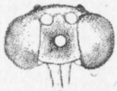
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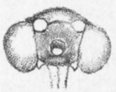
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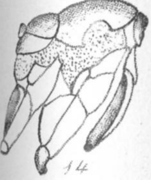
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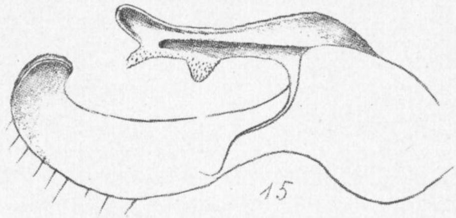
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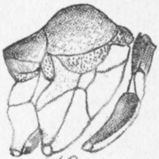
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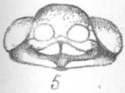
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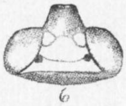
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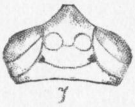
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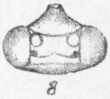
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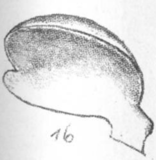
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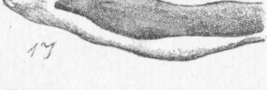
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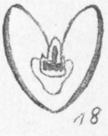
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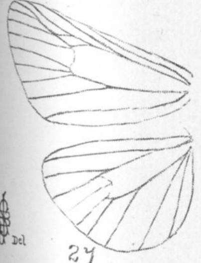
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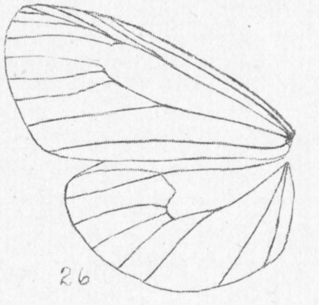
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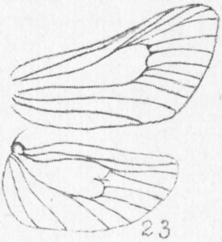
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